he saw a cape which he named Robert Lincoln. These observations are interesting. They seem to show that to the north of the American coast the sea is comparatively landless; while to the north-east the archipelago which borders the north coast of Greenland probably extends for a long distance, perhaps to meet the north-west extension of Franz-Josef Land. Lieut. Greely himself passed the summer of 1882 in the interior of Grinnell Land, in the east of which his station was located. Here he discovered a lake, sixty miles by ten, which he named after General Hazen, the Chief of the Signal Service of the United States.

From all this it is evident that, besides carrying out their strictly scientific work, the geographical explorations of the Greely expedition have been very extensive. From Fort Conger they extended east and west over some 40° of longitude and northward over 3° of latitude. They have enabled us to give more precision on our maps to the north coast of Greenland, and to extend it to the east and north-east. Grinnell Land they have found is an island largely covered by a thick ice-cap with a great lake in the interior, and separated by a narrow channel or fjord from the newly-named Arthur Land to the south. The "palæocrystic ice" of the Nares expedition is a myth, and it is evident that the ice of any part of the Arctic area is for no two successive seasons the same. It must necessarily be continually on the move, piled up in some parts to "palæocrystic" dimensions, while in other parts the sea may be comparatively open. One point seems to us conclusively settled. It is evident from what we know of the present expedition, and of the attempts to rescue it, added to the experience of previous expeditions, that there is no way to the Pole by the Smith Sound route for either ships or sledges. What Lieut. Lockwood saw from his vantage-ground to the north-eastwards seems to us to show that the route by Franz-Josef Land is more hopeful than ever, and that, if another attempt is made to reach the Pole, the choice of a starting-point will probably lie between that land and the New Siberian Islands.

L'ABBÉ MOIGNO

FRANÇOIS NAPOLÉON MARIE MOIGNO, mathematician, physicist, linguist, and ecclesiastic, was born at Guéméné (Morbihan) on April 20, 1804; as he died on Sunday, the 13th instant, he is worthy of a place among the English mathematicians whose names figure in Prof. Sylvester's British Association Address (Exeter, 1869). He was descended from a good old Breton family. Moigno first studied at the Collège de Pontivy, then proceeded to the Jesuit seminary of St. Anne d'Auray. In 1822 he went to another house of the fathers at Montrouge, where he passed his novitiate. In addition to theology he studied with great enthusiasm both the physical and mathematical sciences; in these he made rapid progress, and in 1828 arrived at a new mode of getting the equation to the tangent plane to a surface. Leaving Paris in 1830 on account of the Revolution, he spent some time in Switzerland, and here turned his wonderful powers of memory to the acquisition of some eight new languages, at the same time perfecting his knowledge of Latin and Greek. In 1836 the Jesuits appointed him to the Mathematical Chair in their house in the rue des Postes, Paris. Here he published the first volume of his great work, "Leçons de Calcul differentiel et intégral," following the methods used by, and utilising published and unpublished papers of, Cauchy. As his Superior was opposed to his scientific work, Moigno broke with the order, and gave himself up to his favourite pursuits. Having in 1845 become scientific editor of *L'Époque*, he was sent on account of that journal on a visit to England, Germany, Belgium, and Holland, and furnished to its columns his observations on these countries. About 1850 he filled a similar post on the staffs of *La Presse* and *Le Pays*. In 1852 he became editor-in-chief of *Cosmos*, a weekly scientific review. His connection with this journal closed in 1862, and in 1863 he founded a new journal called *Les Mondes*.

From the above hasty sketch it will be seen how active Moigno was as a journalist. In 1864 he was made a Chevalier of the Legion of Honour. Moigno wrote a number of works bearing on the relation of science and religion. Of his other works we give a few titles:—The continuation of the "Leçons," noted above, the fourth volume containing a part on the Calculus of Variations (written in conjunction with M. Lindeloef, 1861). "Leçons de Mécanique analytique, redigées principalement d'après les Méthodes d'A. Cauchy et étendues aux Travaux les plus recents—Statique." To Liouville he contributed a "Note sur la Détermination du Nombre des Racines réelles ou imaginaires d'une Équation numérique comprises entre des Limites données: Théorèmes de Rolle, de Budan, ou de Fourier, de Descartes, de Sturm, et de Cauchy" (v. 1840), and on a like subject ("Caractère analytique simple et sûr auquel on reconnait que la Méthode de Newton est applicable") to the *Nouvelles Annales de Mathématiques* (x. 1851). But the great part of his writings, by which he is generally known, is physical. The Royal Society's Scientific Catalogue gives the titles of some twenty-five papers, which are concerned mostly with light, electricity, heat, and the solar spectrum; one title only we copy, "Navigation aérienne avec ou sans Ballon," from *Les Mondes*. The "Répertoire d'Optique moderne ou Analyse complète des Travaux modernes relatifs aux Phénomènes de la Lumière" (1847-1850) took him some years to write, and is a work of considerable importance. Another useful summary of results is the "Physique moléculaire, ses Conquêtes, ses Phénomènes, et ses Applications, résumés des travaux accomplis dans les vingt dernières années" (1868).

From his *actualités scientifiques* we single out here "Science Anglaise, son Bilan au mois d'Août, 1868:" this gives from the Norwich meeting of the British Association (Moigno was a Foreign Associate, but was not able to be present at the gathering) the Presidential and seven Vice-Presidential Addresses, and the evening discourses by Huxley and Odling. Dr. Hooker's address was not at all acceptable to Moigno, and he prefaces his translation (" pour effacer quelque peu le fâcheux vernis du positivisme de M. Hooker") with an article of his own, contravening the address of a Positivist Professor, Signor Govi, delivered at Turin.

It is in this last character of a translator of English scientific works (he translated also Père Secchi's work on the Sun) that Moigno did us Englishmen a great service: the following titles will prove this:—"Sur la Radiation" (Tyndall's Rede Lecture); "La Calorescence—Influence des Couleurs et de la Condition mécanique sur la Chaleur rayonnante" (Tyndall); "La Force et la Matière," and "La Force (Tyndall), avec une Appendice sur la Nature et la Constitution intime de la Matière" (by Moigno); "Analyse spectrale des Corps célestes" (Huggins); "Sur la Force de Combinaison des Atomes (Hoffmann), avec addition d'un Aperçu rapide de Philosophie chimique" (by Moigno); "Le Son" (Tyndall); "Six Leçons sur le Chaud et le Froid" (Tyndall). In 1852 appeared a second edition of the "Traité de Télégraphie électrique . . précédée d'un Exposé de la Télégraphie ancienne de Jour et de Nuit," with an atlas; in 1850 he had published his "Proclamation patriotique. Belle Invention française." This is a pamphlet on the invention of tubular bridges by M. J. Guyot. In 1861 he wrote another pamphlet entitled "Cotonisation du Lin," which treats of a practical substitute for cotton. From the titles of these last pamphlets, as well as from those of many of the preceding works,

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it will be seen that Moigno's mind was of a very practical cast, and that he was not immersed in the consideration of theories to the neglect of what is more useful.

THE COMPOSITION OF OCEAN WATER[1]

I.

ALTHOUGH ostensibly a report on the composition of ocean water, this memoir includes in its 250 large quarto pages the record of a far more extensive research than the title implies. It contains a detailed account of seventy-seven complete analyses of sea water, largely accomplished by the use of new and specially invented methods, the record of several independent researches into purely theoretical matters, and a number of exhaustive experimental criticisms of methods employed in similar work by other chemists. Taken altogether, the Report reads like the account of a life-work, and it is wonderful how the immense amount of work described in it could possibly be accomplished in the six years which have elapsed since the return of the Expedition. The rapid completion of the work is in great measure due to Prof. Dittmar's custom of having all the routine determinations made by assistants under his immediate supervision, while he devoted himself specially to the invention and trial of new methods and the repetition of doubtful experiments. The gentlemen who assisted in the research, and whose services Prof. Dittmar is scrupulously careful in acknowledging, are Messrs. John M'Arthur, Robert Lennox, Thomas Barbour, W. G. Johnston, James M. Bowie, James B. M'Arthur, G. A. Darling, and Moses T. Buchanan.

What first strikes a chemical reader on looking through the volume is the essentially mathematical treatment of the whole subject. The value of the statistical method in discussing experimental results has been gradually realised by chemists, but it is questionable if it has ever been applied more fully or with more satisfactory effect than here. The first care in every case, after taking all possible precautions to insure the utmost attainable accuracy, was to ascertain the limiting values of the probable error of the analytical method, and for this purpose there were never less than two and frequently more than four determinations made of each constituent. The utmost pains has been taken to represent the numerical results in as many aspects as possible, in tables, in mathematical formulæ, and by means of curves.

It is only possible here to indicate the principal contents of the six chapters into which the memoir is divided. The consideration of Chapter II. "On the Salinity of Ocean Water," may be conveniently reserved for a subsequent article, where it will be taken up along with Mr. Buchanan's report on the specific gravity of ocean water, which forms Part II. of the volume.

Although sea water had been subjected to many analyses in the earlier part of the present century, the only research of permanent importance until very recently was that of Forchhammer, who analysed a great number of surface waters from all parts of the ocean in 1864. Prof. Dittmar avowedly took this research as a guide, and intended his work to be merely supplementary to it; but from the circumstances of the two chemists the later work tends rather to supersede than to supplement the earlier. Forchhammer dealt with surface water only, collected and brought home in corked bottles by seafaring men who, however willing to do their best, could not be altogether trusted to observe requisite precautions, while Dittmar was supplied with water from all depths of the ocean collected at exactly known positions under the constant supervision of Mr. Buchanan, who secured each sample as it was drawn in a carefully stoppered bottle. We must take into account also the greater delicacy of the balances, and the more perfect analytical methods which are now available. The following table quoted from p. 203 of the Report, shows the most recent numbers assigned to the components of ocean-water salts compared with those given by Forchhammer:—

	Per 100 parts of total salts.		Per 100 parts of halogen calculated as chlorine.		
	Dittmar		Dittmar		Forchhammer
Chlorine	55·292	...	99·848	...	not determined
Bromine	0·1884	...	0·3402	...	,,
Sulphuric acid (SO_3).	6·410	...	11·576	...	11·88
Carbonic acid (CO_2)..	0·152	...	0·2742	...	not determined
Lime (CaO)	1·676	...	3·026	...	2·93
Magnesia (MgO) ...	6·209	...	11·212	...	11·03
Potash (K_2O)	1·332	...	2·405	...	1·93
Soda (Na_2O)	41·234	...	74·462	...	not determined
(Basic oxygen equivalent to the halogens)	−12·493	...	—	...	—
Total salts ...	100·000	...	180·584	...	181·1

More than thirty elements are known to exist in solution in the ocean, but most of these are present in such minute quantity that it was hopeless to attempt to determine them in a number of small samples. Attention was accordingly confined to the chlorine, sulphuric acid, soda, potash, lime, and magnesia, which were estimated with very great accuracy and always by the same method, so that if more exact processes should be discovered at any future time the error of the method used may be calculated once for all, and applied as a correction to each analysis.

This rule of rigid adherence to one system was broken through in one case, that of the potash, where the ordinary process, which was first adopted, proved so unsatisfactory that it was worse than useless to continue to employ it, and the later analyses were conducted by a modification of Finkener's method that gave better results, through a curious balancing of the errors.

For the particular methods employed in each case it is necessary to refer to the memoir itself, where they are described with the utmost detail; but reference must be made to the great improvement which Prof. Dittmar has introduced in what was formerly called volumetric analysis, but which he now prefers to name *titrimetric*. It may be defined, somewhat paradoxically perhaps, as volumetric analysis by weight. The standard solutions are made up as usual by weighing the salt and measuring the water, but the whole solution is afterwards weighed, and its strength is thus determined with great accuracy. A balance combining strength and delicacy to an unusual degree is of course necessary for this purpose. By performing the titration in a weighed phial containing a weighed amount of liquid, and weighing it again after the reagent has been added to the proper amount, the burette error is obviated, except in those cases where the method of zig-zag titration is adopted, and then it only affects the measurements of the few drops of each reagent that are added in turn to produce and destroy the coloration which marks the end-point. All the chlorine determinations were made in this way by Volhard's method of precipitating the halogen by excess of silver nitrate, and estimating this excess by means of a standard solution of ammonium sulphocyanate in presence of iron alum.

The result of the seventy-seven complete analyses of ocean water, the description and discussion of which forms Chapter I., confirms Forchhammer's discovery that the percentage composition of the salts of sea water is the same in all parts of the ocean, and extends it to water from all *depths*. The application of the principle of constant composition to depth is subject to a slight but very important exception. The proportion of *lime* was found by Dittmar to be greater in very deep water than in that near the surface. Although the difference found exceeded

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[1] "The Physics and Chemistry of the Voyage of H.M.S. *Challenger*. Vol. i. Part i. Report on the Composition of Ocean Water." By Prof. W. Dittmar, F.R.SS.L. and E.

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